

Prevalence of specific IgE to the storage mite, *Aleuroglyphus ovatus*

Richard P. Siltan, MD, Enrique Fernández-Caldas, PhD,
Walter L. Trudeau, BA (MOD), Mark C. Swanson, BA, and
Richard F. Lockey, MD Tampa, Fla.

Aleuroglyphus ovatus (Ao) is a storage mite that has a worldwide distribution and has been found in stored bran, wheat, chicken meal, and dried fish products. Ao was isolated from a chicken meal sample, cultured on whole wheat flour at 75% relative humidity, and 1 gm of pure Ao bodies were extracted, 1:20 wt/vol, in 0.2 mol/L of ammonium bicarbonate. Der p I, major allergen of *Dermatophagoides pteronyssinus* (Dp), or Der f I, major allergen to *Dermatophagoides farinae* (Df), was not detected in extracts of Ao. Sodium dodecyl sulfate–polyacrylamide gel electrophoresis revealed 25 bands (6 to 110 kd), and thin-layer isoelectric focusing revealed 19 bands (isoelectric point, 3.5 to 9.3). Sodium dodecyl sulfate–polyacrylamide gel electrophoresis immunoblots with six different sera identified nine IgE binding bands (16 to 100 kd). Thin-layer isoelectric focusing immunoblots identified 16 IgE binding bands (isoelectric point, 4.5 to 9.3). An aliquot of the Ao extract was diluted in bicarbonate buffer (pH 9.2) and adsorbed to plastic microtiter plates. RAST to Ao and Dp were performed with sera of 163 atopic individuals (88 with allergic rhinitis and 75 with allergic asthma with or without allergic rhinitis). All individuals had appropriately positive skin tests that correlated with a history of exacerbation secondary to allergen exposure. RAST results to Dp and Ao were analyzed by regression analysis ($r = 0.64$; $p = 0.0001$). Fifty-five individuals were RAST positive to Dp alone, 32 to Ao and Dp, and three to Ao alone; 73 individuals were negative to Ao and Dp. RAST inhibition demonstrated moderate cross-reactivity between Ao and Dp. (*J ALLERGY CLIN IMMUNOL* 1991;88:595-603.)

Key words: *Aleuroglyphus ovatus*, *Dermatophagoides pteronyssinus*, storage mites, house dust mites, cross-reactivity, skin tests, asthma, allergic rhinitis, immunoblots

Several species of mites have been identified in stored hay, straw, grain, flour, and in house dust samples.¹⁻⁶ Storage mites are not members of the Pyroglyphidae family, whose species, *Dp* and *Df* are major sources of mite allergens in house dust.⁷⁻⁸ Several studies have demonstrated that storage mites are sources of sensitizing allergens in farming environments.^{3, 9-12} Sensitization to storage mites has been confirmed in subjects with allergic asthma and/or rhinitis living in farming communities by skin test, RAST, and nasal or bronchial challenges.^{3, 9, 13, 14} Johansson et al.¹⁵ identified 11 allergens in extracts of the storage mite, *Ld*, by immunoblotting techniques using sera from allergic farmers who were RAST pos-

Abbreviations used

Ao:	<i>Aleuroglyphus ovatus</i>
Ld:	<i>Lepidoglyphus destructor</i>
Tp:	<i>Tyrophagus putrescentiae</i>
Df:	<i>Dermatophagoides farinae</i>
Dp:	<i>Dermatophagoides pteronyssinus</i>
Ca:	<i>Chortoglyphus arcuatus</i>
Der f I:	Major allergen of <i>Df</i>
Der p I:	Major allergen of <i>Dp</i>
MW:	Molecular weight
PBS:	Phosphate-buffered saline
SDS–PAGE:	Sodium dodecyl sulfate–polyacrylamide gel electrophoresis
TLIEF:	Thin-layer isoelectric focusing
AR:	Allergic rhinitis
TC:	Total counts

From the University of South Florida, College of Medicine, Tampa, Fla.

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Reprint requests: Enrique Fernández-Caldas, PhD, Division of Allergy and Immunology, C/O VA Hospital (VAR 111 D), 13000 Bruce B. Downs Blvd., Tampa, FL 33612.

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itive to this mite. Cross-antigenicity and allergenicity of the storage mite, *Tp*, and the house dust mite, *Df*, was demonstrated by Arlian et al.^{16, 17} using crossed immunoelectrophoresis and crossed radioimmuno-

electrophoresis. Griffin et al.¹⁸ studied the allergenic and antigenic relationships among *Dp*, *Acarus siro*, *Glycyphagus destructor*, and *T. longior*. These authors demonstrated that storage mites have unique as well as common allergens. Other studies, with RAST and RAST inhibition, have demonstrated a lack of cross-reactivity between pyroglyphid and storage mites.^{19, 20}

Skin test reactivity to *Ao*, *Df*, *Tp*, *Ca*, *Blomia* sp, and *Suidasia nesbitti* has been demonstrated in a group of house dust-allergic individuals in Japan.²¹ Incomplete cross-antigenicity was noted among these mites, suggesting that each mite species possesses its own specific antigens. Additional studies on the allergenicity of *Ao* have not been reported.

The prevalence of specific IgE to *Acarus siro*, *Ld*, and *T. longior* in an urban population in England has also been described.²² The authors detected a 24% prevalence of specific IgE to *Dp* and a 14% prevalence to at least one of the three storage mites studied. They suggested that some of the positive RAST results to storage mites were a consequence of cross-reactivity with *Dp*. Their findings are in contrast with findings of other authors who found no cross-reactivity between four species of storage mites and *Dp*.²⁰

Ao is a storage mite found in farming environments, has a worldwide distribution, and has been identified in stored bran, flour, wheat, chicken meal, dried fish products, pollards, and rodent nests. Under appropriate conditions, female mites will lay from 33 to 78 fertilized eggs. *Ao* has been successfully cultured on a variety of substrates and multiplies rapidly to form large colonies.²³⁻²⁶

The purpose of this study was to evaluate the prevalence of specific IgE to *Ao* in atopic individuals who live in the Tampa Bay area with skin tests, RAST, RAST inhibition, and immunoblots (SDS-PAGE and TLIEF).

MATERIAL AND METHODS

Serum source and skin testing

Sera were collected from 163 subjects referred to the allergy and immunology clinics of the University of South Florida, College of Medicine, Tampa, Fla., for evaluation of respiratory (upper or lower airways) complaints. There were 93 female and 70 male subjects with a mean age of 30.7 years $\pm$ 11.23 (range, 13 to 73 years). Seventy-five subjects had allergic asthma with or without allergic rhinitis, defined as a history of reversible obstructive airway disease associated with exacerbation secondary to allergen exposure and concomitant skin reactivity to exacerbating allergens. Eighty-eight subjects had AR, defined as a history of rhinitis caused by seasonal and/or perennial allergens with an historical correlation between skin reactivity and exacerbating allergens and no history of asthma. All patients were skin

tested by the epicutaneous method with common aeroallergens of the Tampa Bay area. The skin test battery included extracts of trees (oak, bald cypress, cedar, Australian pine, bayberry, mulberry, elm, sweet gum, hickory, maple, ash, willow, sycamore, pecan, and box elder), grasses (Bahia, Bermuda, rye, Johnson, and timothy), weeds (short ragweed, spiny pigweed, dog fennel, sheep sorrel, lamb's-quarter, marsh elder, and nettle), cat, dog, feathers, cat flea, mites (*Dp* and *Df*), American cockroach, and molds (*Alternaria* spp, *Hormodendrum* spp, *Helminthosporium* spp, *Penicillium* spp, *Aspergillus* spp, *Curvularia* spp, *Stemphylium* spp, *Fusarium* spp, and *Epicoccum* spp). Fifty-two individuals were also skin tested with an *Ao* extract. Skin test results were graded as follows: negative, no reaction; 1+, erythema <21 mm in diameter; 2+, wheal <3 mm and erythema >21 mm in diameter; 3+, wheal $\geq$ 3 mm and surrounding erythema; 4+, wheal with pseudopods and surrounding erythema. Sera were also collected at the same clinics from 126 individuals with no history of allergic respiratory disease and negative skin tests to common aeroallergens.

Mite cultures and preparation of extracts

Ao was isolated from a chicken meal sample collected from a barn just outside Tampa, Fla. The sample was brought in a glass jar to the laboratory and nurtured for 15 days at 75% relative humidity and 25° C. Subsequently, 30 *Ao* mites were removed with a fine needle from the chicken meal and transferred to a plastic jar containing 2 gm of whole wheat flour. Six such cultures were prepared and incubated at 75% relative humidity and 25° C. Other mite species present in the chicken meal sample were *Tp* and *Ca*. *Ao* was also identified in three other barn dust samples collected in Florida (unpublished data). *Ao* cultures were established and checked regularly for cross-contamination with other mites and mold growth. Live mites, separated from the food medium after 2 months with a modified Tullgren apparatus, were killed by freezing for 24 hours. Two and one half grams of these mites were collected and dried over Drierite (W. H. Hammond Drierite Co., Xenia, Ohio) for a week. One gram of dry mites was defatted and extracted overnight, 1:20 wt/vol, in 0.2 mol/L of ammonium bicarbonate and centrifuged at 15,000 rpm in a Beckman (Beckman Instruments, Inc., Irvine, Calif.) centrifuge. The supernatant was dialyzed in 3500 MW cutoff dialysis casings against distilled water. The protein concentration of the *Ao* extract was 2 mg/ml, as measured by the bicinchoninic acid protein assay (Pierce Laboratories, Rockford, Ill.). An extract of the whole wheat used in culture was prepared in the same manner as the mite extract. For skin testing purposes, the *Ao* extract was previously filtered through a 0.2 μ m filter and preserved in 50% glycerin.

RAST

RASTs were performed with sera from atopic individuals and nonatopic control subjects. *Ao* proteins (2 μ g of protein in 100 μ l of 0.1 mol/L of sodium bicarbonate buffer, pH 9.2) were adsorbed to the surface of Immulon-4 microtiter

Removawell strips (Dynatech Laboratories Inc., Alexandria, Va.). The plates were incubated overnight at room temperature and washed three times with RAST wash (0.1 mol/L of potassium phosphate buffer and 1% Tween 20), again incubated overnight with 100 μ l of each serum and washed with RAST wash. The plates were then incubated overnight with 100 μ l of ^{125} I-labeled antihuman IgE, diluted 1:2 (Pharmacia Diagnostics, Piscataway, N.J.), and washed three times in RAST wash. Individual wells were counted for 1 minute in a gamma counter. RASTs to *Dp* with a standardized extract (1.7 mg/ml) and to whole wheat were performed in a similar manner. A RAST result was considered positive when the individual serum bound $\geq 1\%$ of the TCs. The positive control consisted of 100 μ l of a serum pool containing high titers of specific IgE to *Dp* and/or *Ao* and the negative of 100 μ l of a serum pool of *Dp* and *Ao* skin test negative individuals with undetectable levels of specific IgE to these two mites.

RAST inhibition

Cross-reactivity between *Ao* and *Dp* was determined by comparing the capability of each mite extract, at different concentrations, to inhibit the binding of human specific antmite IgE to the allergens of the mite species adsorbed to the plate as the solid phase (*Ao* and *Dp*). RAST-inhibition assays were performed with three different sera (Table I); these sera included a serum pool from four individuals who were RAST positive to *Dp* and *Ao*, a serum sample from an individual who demonstrated high levels of specific IgE to *Ao* and low levels to *Dp* (M. S.), and a serum sample from an individual who demonstrated high levels of specific IgE to *Dp* and low levels to *Ao* (A. M. B.). One hundred microliters of the mite extracts, diluted 1:200 in bicarbonate buffer (pH 9.2), were adsorbed to the surface of plastic microtiter plates overnight. Plates were washed three times with RAST wash, and the inhibition assays were conducted by placing 50 μ l aliquots of serial dilutions (0.5 to 40 μ g/ml) of each mite-allergen extract in an allergen-coated microtiter well together with 50 μ l of human serum. After overnight incubation at room temperature in a humid box, the wells were washed with RAST wash. One hundred microliters of ^{125} I-radiolabeled antihuman IgE were then added to each well. The plates were incubated overnight in a humid box at room temperature and washed, and each microtiter well was counted in a gamma scintillation counter. Results were analyzed with simple regression analysis.

Der p I and *Der f* I allergen content assays

Der p I and *Der f* I were measured in the *Ao* extract with a monoclonal antibody assay previously described.^{27, 28}

TLIEF and TLIEF immunoblots

Individual components of *Ao* were resolved by TLIEF with a 4% polyacrylamide gel incorporating a pH 3 to 10 ampholine gradient (Pharmacia, LKB, Bromma, Sweden) with 1 mol/L of sodium hydroxide and 1 mol/L of phosphoric acid as the anode and cathode buffers, respectively. Samples (50 μ g) were loaded onto wicks placed 2 cm away from the cathode and electrophoresed at 25 W for 90 min-

TABLE I. Specific IgE titers to *Dp* and *Ao* in six subjects

	Subjects	% TC <i>Dp</i>	% TC <i>Ao</i>
1	Serum pool*	25.2	10.27
2	H. S.	25.3	8
3	S. L. N.	26.2	21.5
4	G. S.	17.1	16.0
5	C. H. B.	7.1	8.4
6	M. S.	2.7	26.4
7	A. M. B.	27.1	0.33
8	A. H.†	34.7	9.5

Specific IgE binding to *Dp* and *Ao* in six different individuals.

*Serum pool, subjects 2, 3, 4, and 5.

†Only used in immunoblots.

utes. After electrophoresis, a portion of the gel was removed for Coomassie blue R-250 staining, and the remainder was electroblotted to 0.1 μ m of nitrocellulose at 0.6 mA/cm² for 60 minutes with Tris-glycine-SDS-methanol buffer. Lanes containing the isoelectric point standards were cut from the nitrocellulose sheet and stained sequentially in amido black and India ink. The nitrocellulose strips containing the electroblotted samples were blocked overnight with PBS and 0.01% Tween 20 and 3% bovine serum albumin. The blots were washed five times with PBS-Tween 20 and then incubated overnight with *Ao* RAST-positive sera or RAST-negative control sera diluted 1:3 with PBS-Tween 20. The blots were then washed, incubated overnight with 200 μ l of ^{125} I-labeled antihuman IgE, washed, dried, mounted, and autoradiographed for 72 hours with Kodak X-OMAT AR film (Eastman Kodak Co., Rochester, N.Y.).

SDS-PAGE gels and immunoblots

SDS-PAGE was performed according to the method of Laemmli²⁹ with an LKB vertical slab gel apparatus. A 5% to 20% linear acrylamide gradient gel was used, incorporating a 2.7% cross-linker. Gels were electrophoresed at 30 mA per gel for approximately 4½ hours. Samples were boiled in treatment buffer (SDS, Tris-glycine, and β -mercaptoethanol) for 10 minutes. Seventy-five micrograms of each sample was loaded per lane. MWs were determined with MW markers from Bio-Rad (Rockville Centre, N.Y.). Immunoblots were performed with the LKB Nova Blot system. SDS-PAGE gels were cut into strips and electroblotted to 0.1 μ m pore diameter nitrocellulose. Blotting was carried out at 0.8 mA/cm² with Tris-glycine-SDS-methanol buffer. Efficiency of transfer was determined by Coomassie blue staining of the blotted gel strips. Nitrocellulose strips containing MW standards were cut from sheets and stained with India ink. Blots were blocked with 3% bovine serum albumin in PBS containing 0.01% Tween 20 overnight. The blots were washed five times with PBS-Tween 20 and incubated overnight with an *Ao* RAST-positive serum and a RAST-negative control serum diluted 1:3 in PBS-Tween 20. Serum was removed with five washings of PBS-Tween 20. Then, 200 μ l of ^{125} I-labeled antihuman IgE was added.

TABLE II. Skin tests results of 52 subjects*

Subject No.	<i>Dp</i>	<i>Df</i>	<i>Ao</i>
1	Neg	Neg	Neg
2	4+	4+	4+
3	3+	3+	Neg
4	Neg	Neg	Neg
5	3+	3+	Neg
6	2+	2+	3+
7	4+	4+	4+
8	4+	4+	2+
9	Neg	Neg	Neg
10	Neg	Neg	Neg
11	4+	4+	4+
12	Neg	Neg	Neg
13	Neg	Neg	Neg
14	Neg	1+	Neg
15	2+	Neg	Neg
16	4+	4+	Neg
17	4+	4+	3+
18	4+	4+	Neg
19	3+	4+	2+
20	Neg	Neg	Neg
21	4+	4+	4+
22	4+	4+	4+
23	3+	3+	Neg
24	4+	4+	3+
25	Neg	Neg	Neg
26	4+	4+	Neg
27	3+	3+	2+
28	3+	3+	Neg
29	4+	4+	3+
30	4+	4+	Neg
31	Neg	Neg	Neg
32	1+	1+	Neg
33	Neg	Neg	Neg
34	3+	3+	Neg
35	Neg	Neg	Neg
36	1+	1+	Neg
37	Neg	Neg	Neg
38	Neg	Neg	Neg
39	Neg	Neg	Neg
40	Neg	Neg	Neg
41	Neg	Neg	Neg
42	Neg	Neg	Neg
43	4+	4+	4+
44	Neg	Neg	Neg
45	Neg	Neg	Neg
46	Neg	Neg	Neg
47	4+	4+	Neg
48	Neg	Neg	Neg
49	4+	4+	3+
50	Neg	Neg	Neg
51	Neg	2+	Neg
52	4+	3+	3+

Neg, Negative.

*Evaluated with commercial extracts of *Dp* and *Df* and an in-house extract of *Ao*.

After incubation overnight, the blots were washed five times and autoradiographed for 72 hours.

Statistical analysis

Statistical analyses were performed with a Macintosh SE computer (Apple Computer Inc., Cupertino, Calif.) and the Statview (BrainPower Inc., Ventura, Calif.) and Cricket graph (Cricket Software, Inc., Melvern, Pa.) programs.

RESULTS

Patient population and skin tests

One hundred sixty-three individuals, with allergic respiratory diseases, were skin tested with a battery of common Florida aeroallergens. All the subjects reacted to at least one of the allergens used for skin testing. Thirty individuals had a negative reaction to *Dp*; 14, a 2+ reaction; 15, a 3+ reaction; and 104, a 4+ reaction on epicutaneous skin testing. The 126 nonatopic control subjects had negative skin test reactions to all the aeroallergens tested. A series of 52 individuals was also skin tested with an *Ao* extract; 28 individuals were skin test positive to *Dp* and 15 to *Ao*. A positive skin test to both mites was observed in 15 individuals; 13 were positive to *Dp* and negative to *Ao*. Skin test results are presented in Table II.

RAST

Prevalence of specific IgE to *Ao*, *Dp*, and whole wheat was studied in all subjects with RAST. One serum, which did not bind to *Ao*, bound 2.3% TC to a whole wheat flour extract. Mean specific IgE binding of sera to the wheat extract was 0.1% TC. A box-plot analysis of the positive RAST results to *Ao* and *Dp* is illustrated in Fig. 1. The five horizontal lines on each box plot illustrate the 10th, 25th, 50th, 75th, and 90th percentiles. The values above and below the 10th and 90th percentile are represented as data points.

The mean percent TC $\pm$ SD of the RAST results were as follows: 55 individuals were positive to *Dp* alone (6.74 ± 7.21), 32 were positive to *Dp* (14.54 $\pm$ 12.98) and *Ao* (7.23 $\pm$ 9.18), three were positive to *Ao* alone (1.80 ± 0.57), and 73 individuals were nonreactive. Regression analysis of the RAST results to *Ao* and *Dp* is illustrated in Fig. 2 ($r = 0.64$; $p = 0.0001$). RAST results to *Dp* and *Ao* were compared in the subjects with rhinitis and the subjects with asthma with or without rhinitis. The mean percent TC $\pm$ SD in these two groups is presented in Table III. All serum samples from 126 healthy nonatopic control individuals bound <1% of TC to both *Ao* and *Dp*.

Cross-reactivity between *Dp* and *Ao*

RAST-inhibition experiments were performed with a serum pool of four individuals with high titers of

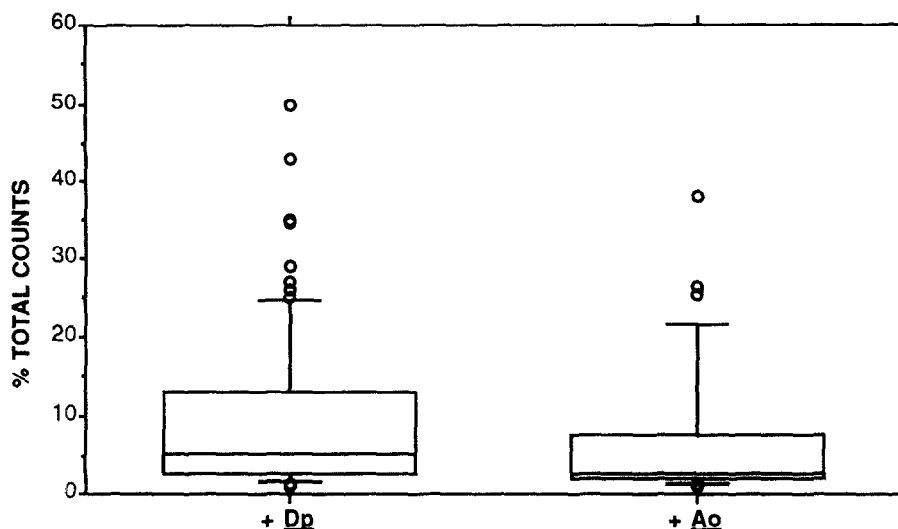


FIG. 1. Box plot analysis of positive RAST results, 87 to *Dp* and 35 to *Ao*.

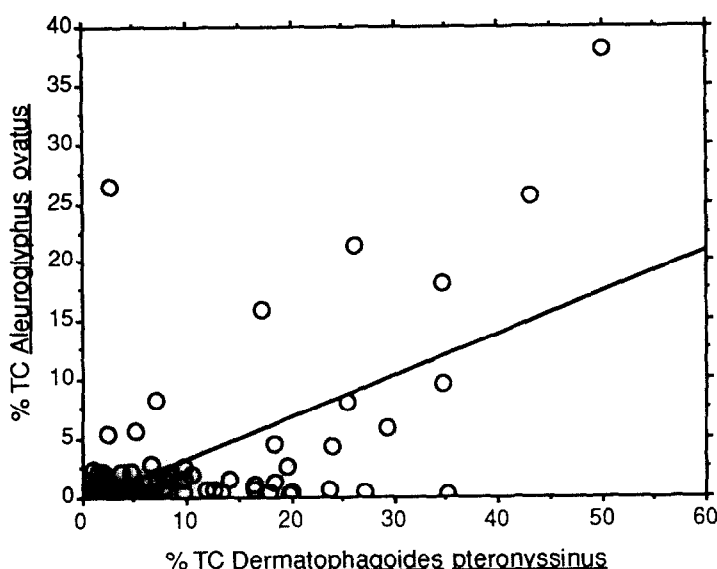


FIG. 2. Regression analysis of 163 RAST results to *Dp* and *Ao*; $r = 0.64$; $p \leq 0.0001$.

specific IgE to *Ao* and *Dp* and sera from two different individuals (M. S. and A. M. B.). Specific IgE titers to *Ao* and *Dp* of each individual serum are presented in Table I.

RAST-inhibition assays demonstrated moderate cross-reactivity between *Dp* and *Ao* (Figs. 3 and 4). *Ao* allergens in the fluid phase did not inhibit the binding of specific IgE to *Dp* solid phase when the serum pool or serum of A. M. B. was used. *Dp* allergens in the fluid phase inhibited up to 68% of the binding of specific IgE to *Ao* solid phase when the serum pool was used and up to 24% when serum of M. S. was used. Both mite extracts demonstrated autologous inhibition. No cross-reactivity was found be-

tween *Ao* and whole wheat flour. *Der p* I and *Der f* I allergens were not detected in the *Ao* extract.

SDS-PAGE, TLIEF, and immunoblots

SDS-PAGE revealed 25 bands with an MW range of 6 to 110 kd (Fig. 5). TLIEF revealed 19 bands in the pH range of 3.5 to 9.3 (Fig. 6). SDS-PAGE immunoblots identified up to nine IgE binding bands (MW, 16 to 110 kd) when sera of H. S., S. L. N., G. S., C. H. B., or M. S. were used; no IgE binding bands were noted when negative control sera or serum of A. M. B. was used (Fig. 7). TLIEF immunoblots demonstrated up to 16 IgE binding bands (pH 4.5 to 9.3) with sera (H. S., S. L. N., G. S., C. H. B., and

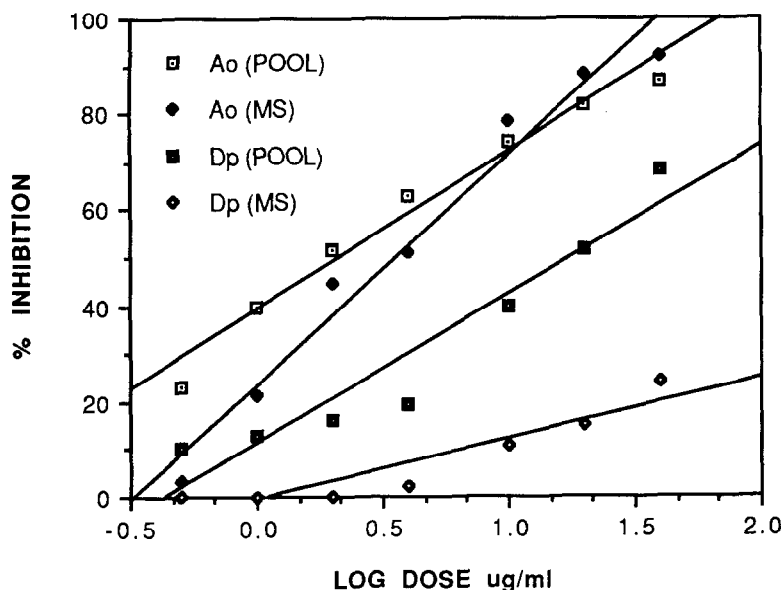


FIG. 3. RAST-inhibition results when *Dp* is used on the solid phase. *Parallel lines* were observed when serum of A. M. B. and the sera pool were used. In both cases, *Dp* inhibited IgE binding to *Dp* by 80%. *Ao* did not inhibit *Dp* when the sera pool or serum of A. M. B. was used.

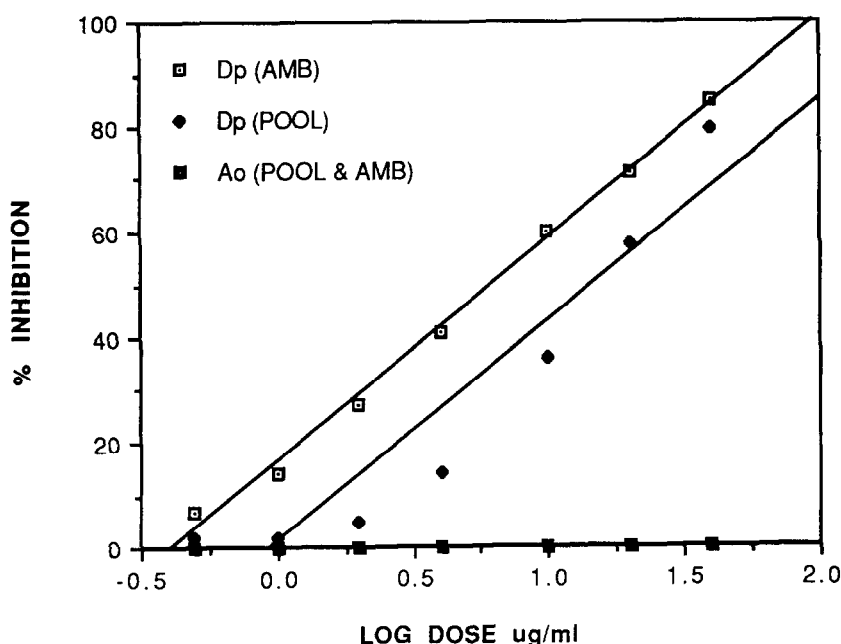


FIG. 4. RAST-inhibition results when *Ao* was used in the solid phase. With serum of M. S. and the pool, *Ao* achieved >80% inhibition. *Dp* inhibited >60% when the sera pool was used, and 20% when serum of M. S. was used.

M. S.) or serum of A. H. (only used in the TLIEF immunoblots). No IgE binding bands were noted when serum of A. M. B. was used (Fig. 8).

DISCUSSION

Allergy to storage mites has gained increasing interest in recent years. In our study, specific IgE to *Ao*

was detected in 35 individuals (three to *Ao* alone and 32 to both *Ao* and *Dp*). Only one individual who was both skin test and RAST negative to *Dp* was RAST positive to *Ao*. Serum from one patient (A. M. B.) had high specific IgE levels to *Dp* and very low levels to *Ao*. However, serum from another patient (M. S.) contained higher levels of specific IgE to *Ao* than to

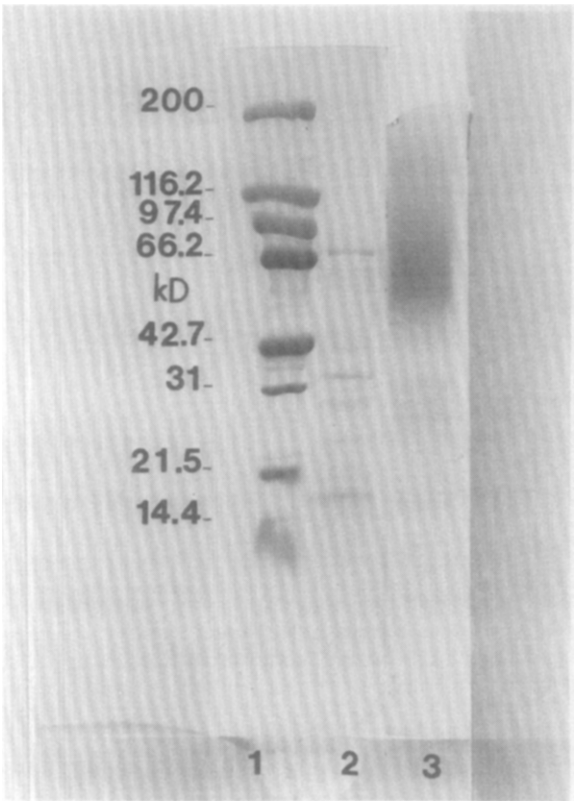


FIG. 5. Coomassie blue-stained gradient gel; *lane 1*, MW standards; *lane 2*, *Dp* extract; *lane 3*, *Ao* extract.

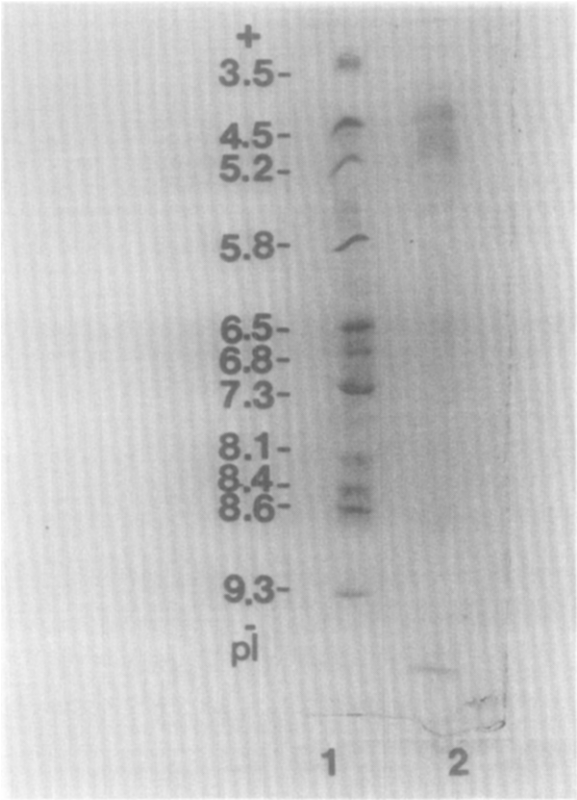


FIG. 6. Coomassie blue-stained TLIEF gel; *lane 1*, isoelectric point standard (pH 3.5 to 9.5); *lane 2*, *Ao* extract.

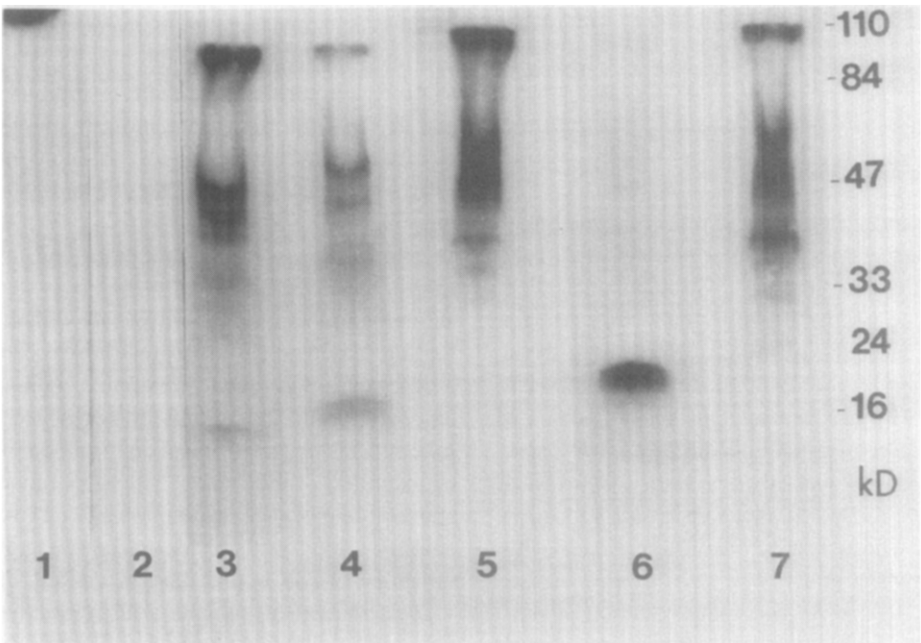


FIG. 7. Autoradiograph of an electroblotted SDS-PAGE gel; *lane 1*, negative control serum; *lane 2*, serum from A. M. B.; *lane 3*, serum from S. L. N.; *lane 4*, serum from G. S.; *lane 5*, serum from M. S.; *lane 6*, serum from H. S.; *lane 7*, serum from C. H. B.

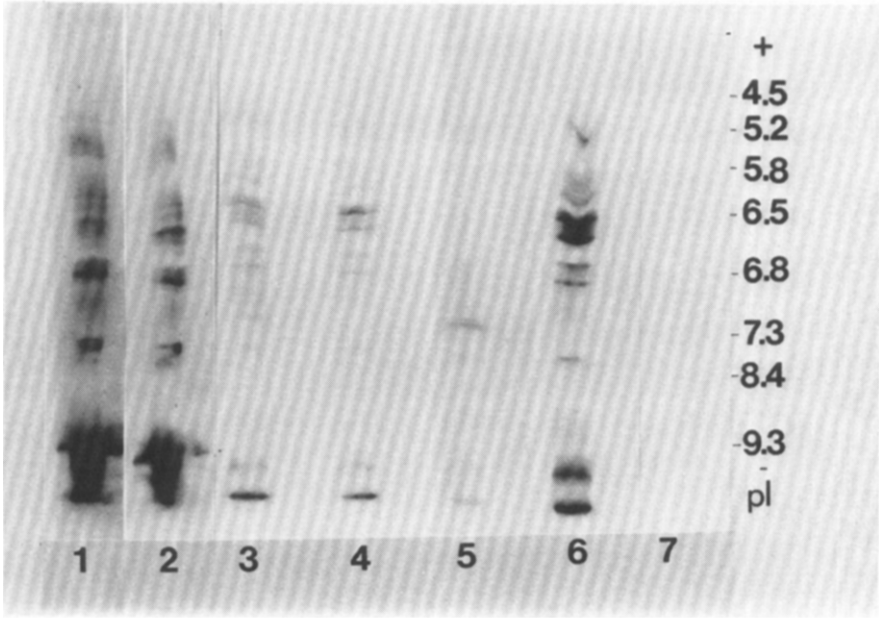


FIG. 8. Autoradiograph of electroblotted TLIEF gel; *lane 1*, serum from S. L. N.; *lane 2*, serum from M. S.; *lane 3*, serum from G. S.; *lane 4*, serum from C. H. B.; *lane 5*, serum from H. S.; *lane 6*, serum from A. H.; *lane 7*, serum from A. M. B.

TABLE III. Specific IgE to *Dp* and *Ao* in 163 allergic subjects

	% TC <i>Dp</i>	% TC <i>Ao</i>
Asthma ± rhinitis (N = 75)	9.5 ± 11.4*	3.2 ± 6.9†
Rhinitis (N = 88)	1.7 ± 2.9*	0.5 ± 0.7†

Mean ± SD of specific IgE binding to *Dp* and *Ao* in two groups of allergic individuals.

**p* ≤ 0.001.

†*p* ≤ 0.001.

Dp. By history and skin testing, it was concluded that house dust mites played an important causative role in these two patients with asthma. Other patients, such as S. L. N., recognized allergens in both mite extracts (Table I). The presence of unique allergens in these mites is indicated by the fact that some patients have a positive RAST only against *Dp* or *Ao*. Skin test results of 52 consecutive patients indicated that a positive skin test to *Ao* was always associated with a positive skin test to *Dp* and that sensitization to *Ao* is very common. These results are in agreement with results of Luczynska et al.²²

A positive RAST to *Ao* was more common in subjects with asthma with or without AR than in subjects with only AR; 83% of the individuals with a positive RAST to *Ao* had asthma. Similar results have been reported in a study of the clinical significance and allergenic cross-reactivity of *Euroglyphus maynei* and other nonpyroglyphid and pyroglyphid mite spe-

cies. Farmers with asthma alone or in combination with rhinitis are more frequently sensitized to storage mites and house dust mites than farmers with rhinitis alone.¹⁹ Sensitization to storage mites appears to be more common in allergic subjects with asthma than in patients with AR living in an urban center in Florida.³⁰

Cross-reactivity studies between *Dp* and *Ao* demonstrated that *Dp* inhibits the binding of specific IgE to *Ao* to a greater degree than *Ao* inhibits *Dp*. RAST and RAST-inhibition data indicate moderate cross-reactivity between *Dp* and *Ao*. Monoclonal antibody assays demonstrated that *Der p* I and *Der f* I are not present in *Ao* extracts.

Although *Ao* is not commonly found in house dust in this area, we identified a high prevalence of sensitization to this mite in individuals with asthma. This finding may result from a previous exposure to *Ao* in a different environment, a variable immune response among exposed individuals, the presence of multiple mite species in a subtropical environment, a long-term exposure to high mite allergen concentrations, and/or the presence of unique and common allergens among various mite species. Since *Ao* is not a common inhabitant of the house dust in central Florida,⁶ we suspect that most patients with a positive RAST to *Dp* and *Ao* recognize common allergens in these two mite species. However, some patients appear to recognize allergens that are unique to *Ao*. The presence of specific IgE to *Ao* may also be the result of sensitization to other storage mite species, which are more common in the Tampa Bay area, such as *Tp*, *Ca*, and

Blomia tropicalis, and demonstrate significant cross-reactivity with *Ao*.^{31, 32} A high prevalence of sensitization to storage mites, especially among subjects with asthma, has been identified in this area, and a significant degree of cross-reactivity has been detected between *Ao* and other storage mites.³¹⁻³³

Additional investigations of the antigenic and allergenic properties of storage mites are needed because exposure to their antigens may occur in homes and in the workplace. Storage mite allergy has been recognized among farming populations, but the detection of specific IgE to AO in urban dwellers indicates that IgE-mediated disease to storage mites is not restricted to a particular environment and that storage mites may contain important cross-reacting as well as unique allergens.

REFERENCES

1. Terho EO, Leskinen L, Husman K, Karenlampi L. Occurrence of storage mites in Finnish farming environments. *Allergy* 1982;37:15-9.
2. Jeffrey IG. A survey of the mite fauna of Scottish farms. *J Stored Prod Res* 1976;12:149-56.
3. Cuthbert OD, Brostoff J, Wraith DG, Brighton WD. "Barn allergy": asthma and rhinitis due to storage mites. *Clin Allergy* 1979;9:229-36.
4. Korsgaard J, Hallas TE. Tarsonemid mites in Danish house dust. *Allergy* 1979;34:225-32.
5. Stenius B, Cunningham AM. House dust mites and respiratory allergy: a qualitative survey of species occurring in Finnish house dust. *Scand J Respir Dis* 1972;53:338-48.
6. Fernández-Caldas E, Fox RW, Bucholtz GA, Trudeau WL, Ledford DK, Lockey RF. House dust mite allergy in Florida: mite survey in households of mite-sensitive individuals in Tampa, FL. *Allergy Proc* 1990;11(6):263-7.
7. Voorhorst R, Spijkstra FThM, Varekamp H, Leupen MJ, Lykema AW. The house-dust mite (*Dermatophagoides pteronyssinus*) and the allergens it produces: identity with the house-dust allergen. *J ALLERGY* 1967;39:325-39.
8. Chapman MD, Platts-Mills TAE. Purification and characterization of the major allergen from *Dermatophagoides pteronyssinus*-antigen P₁. *J Immunol* 1980;125:587-92.
9. van Hage-Hamsten M, Johansson SGO, Höglund S, Tüll P, Wirén A, Zetterstrom O. Storage mite allergy is common in a farming population. *Clin Allergy* 1985;15:555-64.
10. Terho EO, Husman K, Vohlonen I, Rautalahti M, Tukiainen H. Allergy to storage mites or cow dander as a cause of rhinitis among Finnish dairy farmers. *Allergy* 1985;40:23-6.
11. van Hage-Hamsten M, Johansson SGO, Zetterström O. Prevalence of mite allergy over allergy to pollens and animal danders in a farming population. *Clin Allergy* 1987;17:417-23.
12. Revsbech P, Andersen G. Storage mite allergy among grain elevator workers. *Allergy* 1987;42:423-9.
13. Ingram CG, Jeffrey IG, Symington IS, Cuthbert OD. Bronchial provocation studies in farmers allergic to storage mites. *Lancet* 1979;2:1330-2.
14. Wraith DG, Cunningham AM, Seymour WM. The role and allergenic importance of storage mites in house dust and other environments. *Clin Allergy* 1979;9:545-61.
15. Johansson E, van Hage-Hamsten M, Johansson SGO. Demonstration of allergen components in the storage mite *Lepidoglyphus destructor* by an immunoblotting technique. *Int Arch Allergy Appl Immunol* 1988;85:8-13.
16. Arlian LG, Geis DP, Vyszynski-Moher DL, Bernstein IL, Gallagher JS. Crossed antigenic and allergenic properties of the house dust mite *Dermatophagoides farinae* and the storage mite *Tyrophagus putrescentiae*. *J ALLERGY CLIN IMMUNOL* 1984;74:172-9.
17. Arlian LG, Geis DP, Vyszynski-Moher DL, Bernstein IL, Gallagher JS. Antigenic and allergenic properties of the storage mite *Tyrophagus putrescentiae*. *J ALLERGY CLIN IMMUNOL* 1984;74:166-71.
18. Griffin P, Ford AW, Alterman L, et al. Allergenic and antigenic relationship between three species of storage mites and the house dust mite, *Dermatophagoides pteronyssinus*. *J ALLERGY CLIN IMMUNOL* 1989;84:108-17.
19. van Hage-Hamsten M, Johansson SGO. Clinical significance and allergenic cross-reactivity of *Euroglyphus maynei* and other nonpyroglyphid and pyroglyphid mites. *J ALLERGY CLIN IMMUNOL* 1989;83:581-9.
20. van Hage-Hamsten M, Johansson SGO, Johansson E, Wirén A. Lack of allergenic cross-reactivity between storage mites and *Dermatophagoides pteronyssinus*. *Clin Allergy* 1987;17:23-31.
21. Miyamoto T, Oshima S, Mizuno K, Sasa M, Ishizaki T. Cross-antigenicity among six species of dust mites and house dust antigens. *J ALLERGY* 1969;44:228-38.
22. Luczynska CH, Griffin P, Davies RJ, Topping MD. Prevalence of specific IgE to storage mites (*A. siro*, *L. destructor*, and *T. longior*) in an urban population and cross-reactivity with the house dust mite (*D. pteronyssinus*). *Clin Exp Allergy* 1990;20:403-6.
23. Hughes AM. The mites of stored food and houses. *Min Agric Fish Food (London) Tech Bull* 9 1976.
24. Hsin K, Chin C. Studies on the life history of *Aleuroglyphus ovatus* Troupeau (Acarina: Acaridae). *Act Ent Sinica* 1964;13:428-35.
25. Pimental D, Rumsey MW, Streams FA. Rearing tyroglyphid mites on *Neurospora*. *Ann Ent Soc Am* 1960;53:549.
26. Sinha RN. Feeding and reproduction of some stored-product mites on seed-borne fungi. *J Econ Entomol* 1966;59(5):1227-32.
27. Swanson MC, Campbell AR, Klauck J, Reed CE. Correlation between levels of mite and cat allergens in settled and airborne dust. *J ALLERGY CLIN IMMUNOL* 1989;83:776-83.
28. Chapman MD, Heymann PW, Wilkins SR, Brown MJ, Platts-Mills TAE. Monoclonal immunoassays for major dust mite (*Dermatophagoides*) allergens *Der p 1* and *Der f 1*, and quantitative analysis of the allergen content of mite and house dust extracts. *J ALLERGY CLIN IMMUNOL* 1987;80:184-94.
29. Laemmli UK. Cleavage of structural proteins during the assembly of the head of bacteriophage T4. *Nature* 1970;227:680.
30. Fernández-Caldas E, Trudeau WL, Fox RW, Bucholtz GA, Lockey RF. Comparison of mite-specific IgE and total IgE levels in rhinitis and asthma patients [Abstract]. *J ALLERGY CLIN IMMUNOL* 1990;85(1):183.
31. Trudeau W, Fernández-Caldas E, May J, Pratt D, Lockey RF. Allergenicity of the mite *Chortoglyphus arcuatus* [Abstract]. *J ALLERGY CLIN IMMUNOL* 1991;85(1):238.
32. Caraballo L, Puerta L, Fernández-Caldas E, Lockey RF. Cross-reactivity among *Aleuroglyphus ovatus*, *Chortoglyphus arcuatus*, and *Dermatophagoides pteronyssinus* [Abstract]. *J ALLERGY CLIN IMMUNOL* 1991;87(1):189.
33. Fernández-Caldas E, Trudeau WL, García-Ramos E, van Hage-Hamsten M, Johansson SGO, Lockey RF. Sensitization to house and storage mites in urban dwellers [Abstract]. *J ALLERGY CLIN IMMUNOL* 1991;87(1):322.